



# STGP10NC60KD - STGF10NC60KD STGB10NC60KD

N-CHANNEL 10A - 600V - TO-220/TO-220FP/D<sup>2</sup>PAK  
SHORT CIRCUIT RATED PowerMESH™ IGBT

Table 1: General Features

TYPE	V <sub>CES</sub>	V <sub>CE(sat)</sub> (Max) @ 25°C	I <sub>C</sub> @ 100°C
STGB10NC60KD	600 V	< 2.5 V	10 A
STGF10NC60KD	600 V	< 2.5 V	6 A
STGP10NC60KD	600 V	< 2.5 V	10 A

- LOWER ON-VOLTAGE DROP (V<sub>cesat</sub>)
- OFF LOSSES INCLUDE TAIL CURRENT
- LOWER C<sub>RES</sub> / C<sub>IES</sub> RATIO
- SWITCHING LOSSES INCLUDE DIODE RECOVERY ENERGY
- VERY SOFT ULTRA FAST RECOVERY ANTIPARALLEL DIODE
- NEW GENERATION PRODUCTS WITH TIGHTER PARAMETER DISTRIBUTION

## DESCRIPTION

Using the latest high voltage technology based on a patented strip layout, STMicroelectronics has designed an advanced family of IGBTs, the PowerMESH™ IGBTs, with outstanding performances. The suffix “K” identifies a family optimized for high frequency motor control applications with short circuit withstand capability.

## APPLICATIONS

- HIGH FREQUENCY MOTOR CONTROLS
- SMPS and PFC IN BOTH HARD SWITCH AND RESONANT TOPOLOGIES
- MOTOR DRIVERS

Figure 1: Package

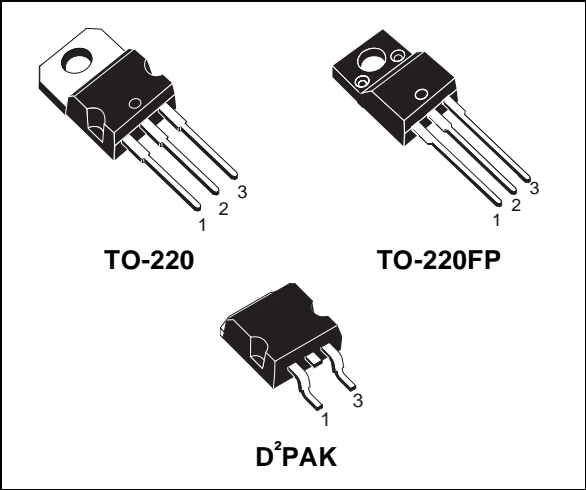


Figure 2: Internal Schematic Diagram

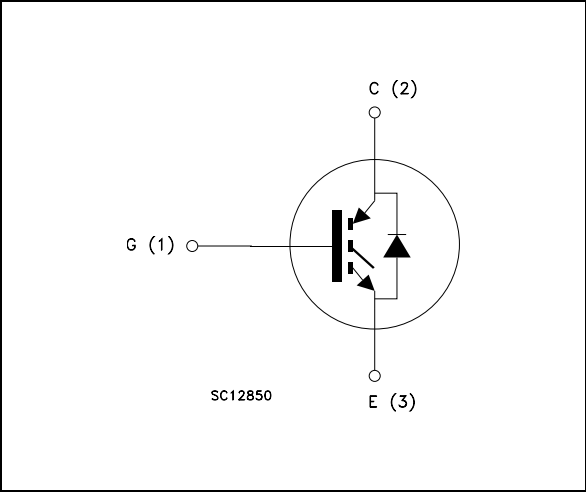


Table 2: Order Codes

SALES TYPE	MARKING	PACKAGE	PACKAGING
STGB10NC60KDT4	GB10NC60KD	D <sup>2</sup> PAK	TAPE & REEL
STGF10NC60KD	GF10NC60KD	TO-220FP	TUBE
STGP10NC60KD	GP10NC60KD	TO-220	TUBE

## STGP10NC60KD - STGB10NC60KD - STGF10NC60KD

**Table 3: Absolute Maximum ratings**

Symbol	Parameter	Value		Unit
		STGB10NC60KD STGP10NC60KD	STGF10NC60KD	
V <sub>CES</sub>	Collector-Emitter Voltage (V <sub>GS</sub> = 0)	600		V
V <sub>ECR</sub>	Emitter-Collector Voltage	20		V
V <sub>GE</sub>	Gate-Emitter Voltage	±20		V
I <sub>C</sub>	Collector Current (continuous) at T <sub>C</sub> = 25°C (#)	20	9	A
I <sub>C</sub>	Collector Current (continuous) at T <sub>C</sub> = 100°C (#)	10	6	A
I <sub>CM</sub> (■)	Collector Current (pulsed)	40		A
I <sub>F</sub>	Diode RMS Forward Current at T <sub>C</sub> = 25°C	10		A
P <sub>TOT</sub>	Total Dissipation at T <sub>C</sub> = 25°C	60	25	W
	Derating Factor	0.48	0.20	W/°C
V <sub>ISO</sub>	Insulation Withstand Voltage A.C.(t = 1 sec; T <sub>C</sub> = 25°C)	--	2500	V
T <sub>stg</sub>	Storage Temperature	– 55 to 150		°C
T <sub>j</sub>	Operating Junction Temperature			

(■) Pulse width limited by max. junction temperature.

**Table 4: Thermal Data**

			Min.	Typ.	Max.	
R <sub>thj-case</sub>	Thermal Resistance Junction-case	TO-220 D2PAK			2.08	°C/W
		TO-220FP			5.0	°C/W
R <sub>thj-amb</sub>	Thermal Resistance Junction-ambient				62.5	°C/W
T <sub>L</sub>	Maximum Lead Temperature for Soldering Purpose (1.6 mm from case, for 10 sec.)			300		°C

### ELECTRICAL CHARACTERISTICS (T<sub>CASE</sub> = 25°C UNLESS OTHERWISE SPECIFIED)

**Table 5: Main Parameters**

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V <sub>BR(CES)</sub>	Collector-Emitter Breakdown Voltage	I <sub>C</sub> = 1 mA, V <sub>GE</sub> = 0	600			V
I <sub>CES</sub>	Collector cut-off Current (V <sub>GE</sub> = 0)	V <sub>CE</sub> = Max Rating, T <sub>C</sub> = 25°C V <sub>CE</sub> = Max Rating, T <sub>C</sub> = 125°C			10 1	μA mA
I <sub>GES</sub>	Gate-Emitter Leakage Current (V <sub>CE</sub> = 0)	V <sub>GE</sub> = ±20V, V <sub>CE</sub> = 0			±100	nA
V <sub>GE(th)</sub>	Gate Threshold Voltage	V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 250 μA	5		7	V
V <sub>CE(sat)</sub>	Collector-Emitter Saturation Voltage	V <sub>GE</sub> = 15V, I <sub>C</sub> = 5A V <sub>GE</sub> = 15V, I <sub>C</sub> = 5A, T <sub>C</sub> = 125°C		2 1.8	2.5	V V

(#) Calculated according to the iterative formula:

$$I_C(T_C) = \frac{T_{JMAX} - T_C}{R_{THJ-C} \times V_{CESAT(MAX)}(T_C, I_C)}$$

## ELECTRICAL CHARACTERISTICS (CONTINUED)

Table 6: Dynamic

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$g_{fs}(1)$	Forward Transconductance	$V_{CE} = 15\text{ V}$ , $I_C = 5\text{ A}$		15		S
$C_{ies}$ $C_{oes}$ $C_{res}$	Input Capacitance Output Capacitance Reverse Transfer Capacitance	$V_{CE} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GE} = 0$		380 46 8.5		pF pF pF
$Q_g$ $Q_{ge}$ $Q_{gc}$	Total Gate Charge Gate-Emitter Charge Gate-Collector Charge	$V_{CE} = 390\text{ V}$ , $I_C = 5\text{ A}$ , $V_{GE} = 15\text{ V}$ , (see Figure 20)		19 5 9		nC nC nC
$t_{scw}$	Short Circuit Withstand Time	$V_{CE} = 0.5 V_{BR(CEs)}$ , $T_J = 125^\circ\text{C}$ $R_G = 10\ \Omega$ , $V_{GE} = 12\text{ V}$	10			$\mu\text{s}$

Table 7: Switching On

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$ $t_r$ $(di/dt)_{on}$	Turn-on Delay Time Current Rise Time Turn-on Current Slope	$V_{CC} = 390\text{ V}$ , $I_C = 5\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 25^\circ\text{C}$ (see Figure 18)		17 6 655		ns ns A/ $\mu\text{s}$
$t_{d(on)}$ $t_r$ $(di/dt)_{on}$	Turn-on Delay Time Current Rise Time Turn-on Current Slope	$V_{CC} = 390\text{ V}$ , $I_C = 5\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 125^\circ\text{C}$ (see Figure 18)		16.5 6.5 575		ns ns A/ $\mu\text{s}$

Table 8: Switching Off

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_r(V_{off})$ $t_{d(off)}$ $t_f$	Off Voltage Rise Time Turn-off Delay Time Current Fall Time	$V_{CC} = 390\text{ V}$ , $I_C = 5\text{ A}$ , $R_{GE} = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ $T_J = 25^\circ\text{C}$ (see Figure 18)		33 72 82		ns ns ns
$t_r(V_{off})$ $t_{d(off)}$ $t_f$	Off Voltage Rise Time Turn-off Delay Time Current Fall Time	$V_{CC} = 390\text{ V}$ , $I_C = 5\text{ A}$ , $R_{GE} = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ $T_J = 125^\circ\text{C}$ (see Figure 18)		60 106 136		ns ns ns

Table 9: Switching Energy

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$E_{on}(2)$ $E_{off}(3)$ $E_{ts}$	Turn-on Switching Losses Turn-off Switching Losses Total Switching Losses	$V_{CC} = 390\text{ V}$ , $I_C = 75\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 25^\circ\text{C}$ (see Figure 18)		55 85 140		$\mu\text{J}$ $\mu\text{J}$ $\mu\text{J}$
$E_{on}(2)$ $E_{off}(3)$ $E_{ts}$	Turn-on Switching Losses Turn-off Switching Losses Total Switching Losses	$V_{CC} = 390\text{ V}$ , $I_C = 5\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 125^\circ\text{C}$ (see Figure 18)		87 162 249		$\mu\text{J}$ $\mu\text{J}$ $\mu\text{J}$

(1) Pulsed: Pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%

(2)  $E_{on}$  is the turn-on losses when a typical diode is used in the test circuit in figure 2. If the IGBT is offered in a package with a co-pack diode, the co-pack diode is used as external diode. IGBTs & DIODE are at the same temperature (25°C and 125°C)

(3) Turn-off losses include also the tail of the collector current.

**Table 10: Collector-Emitter Diode**

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_f$	Forward On-Voltage	$I_f = 2.5\text{ A}$ $I_f = 2.5\text{ A}, T_j = 125\text{ °C}$		1.6 1.3	2.1	V V
$t_{rr}$ $Q_{rr}$ $I_{rrm}$	Reverse Recovery Time Reverse Recovery Charge Reverse Recovery Current	$I_f = 5\text{ A}, V_R = 30\text{ V},$ $T_j = 25\text{ °C}, di/dt = 100\text{ A/}\mu\text{s}$ (see Figure 6)		23.5 16.5 1.4		ns nC A
$t_{rr}$ $Q_{rr}$ $I_{rrm}$	Reverse Recovery Time Reverse Recovery Charge Reverse Recovery Current	$I_f = 5\text{ A}, V_R = 30\text{ V},$ $T_j = 125\text{ °C}, di/dt = 100\text{ A/}\mu\text{s}$ (see Figure 6)		39 39 2		ns nC A

Figure 3: Output Characteristics

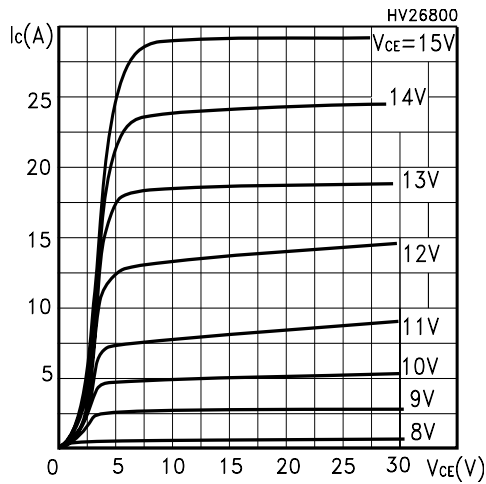


Figure 4: Transconductance

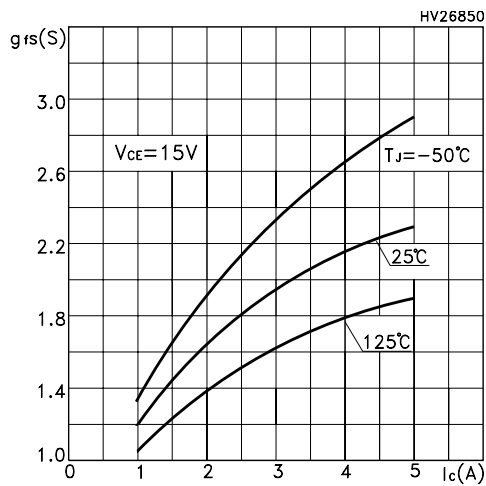


Figure 5: Collector-Emitter On Voltage vs Collector Current

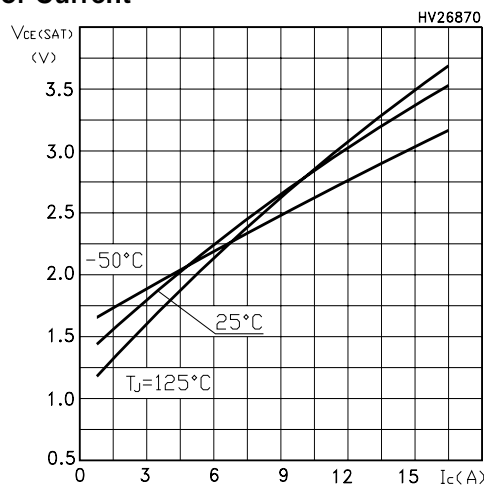


Figure 6: Transfer Characteristics

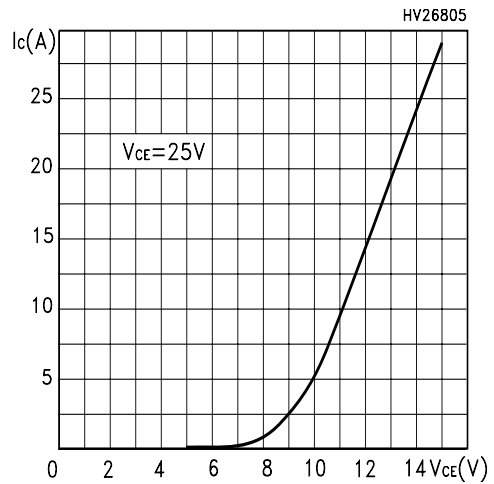


Figure 7: Collector-Emitter On Voltage vs Temperature

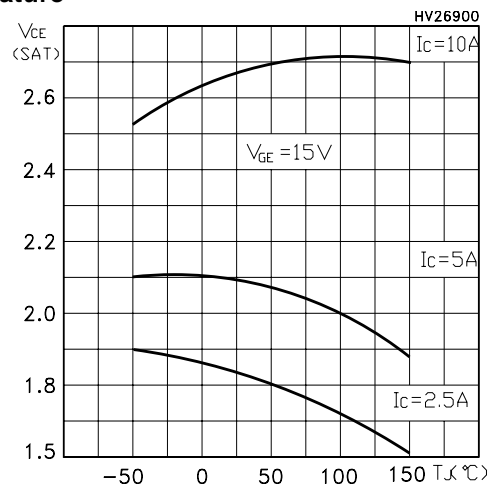


Figure 8: Normalized Gate Threshold vs Temperature

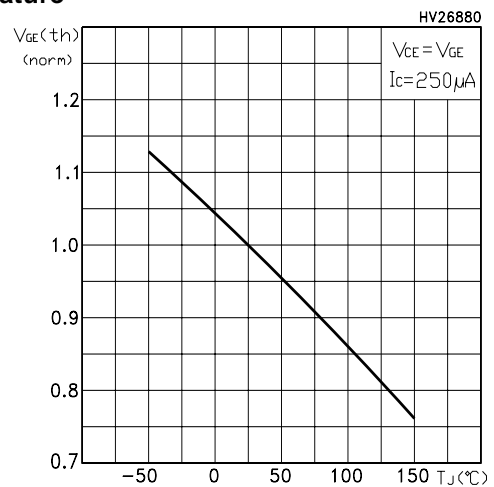


Figure 9: Normalized Breakdown Voltage vs Temperature

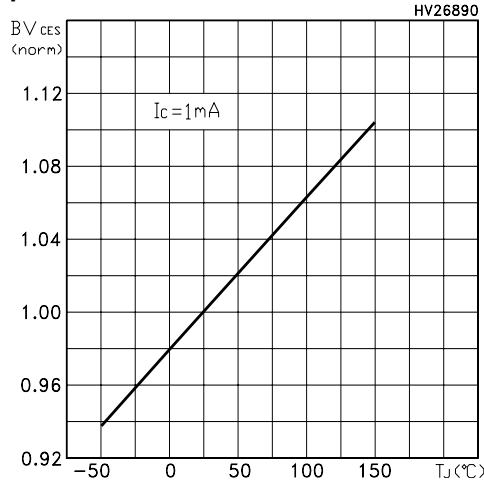


Figure 10: Capacitance Variations

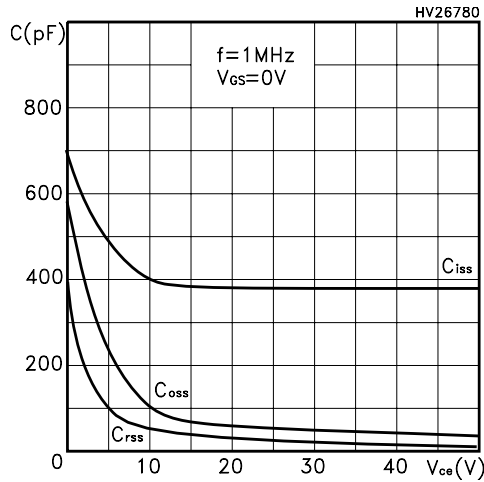


Figure 11: Total Switching Losses vs Gate Resistance

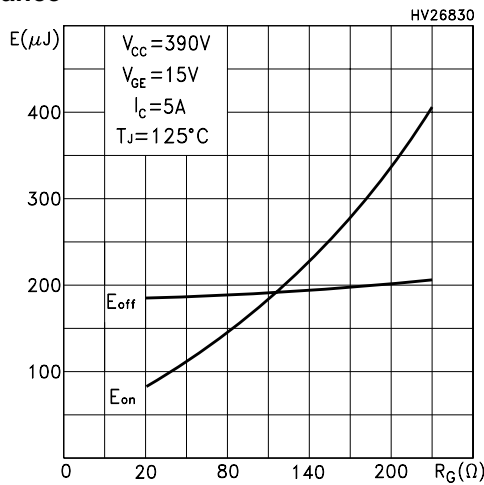


Figure 12: Gate Charge vs Gate-Emitter Voltage

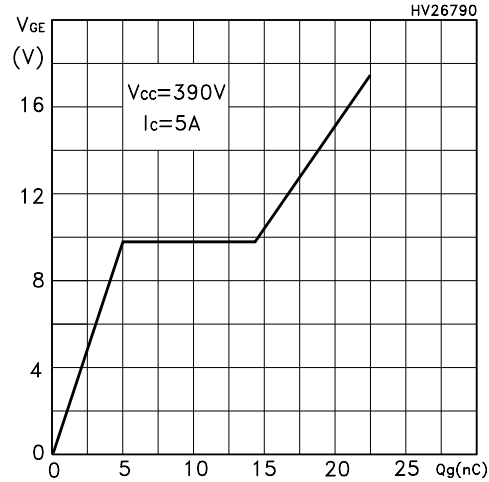


Figure 13: Total Switching Losses vs Temperature

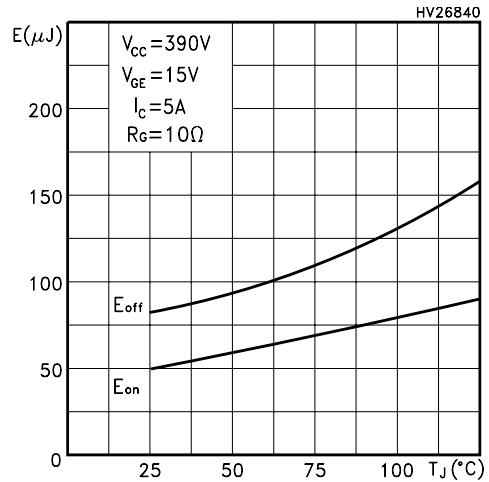


Figure 14: Total Switching Losses vs Collector Current

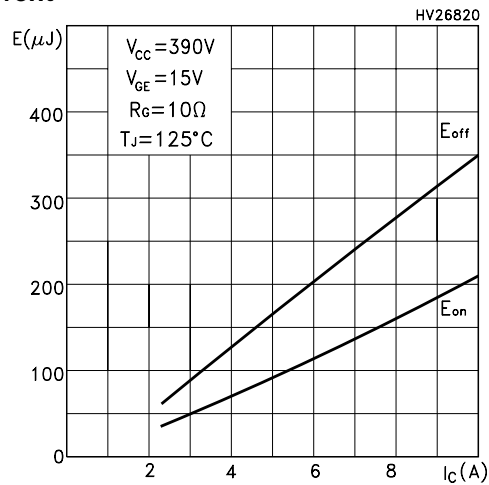


Figure 15: Turn-Off SOA

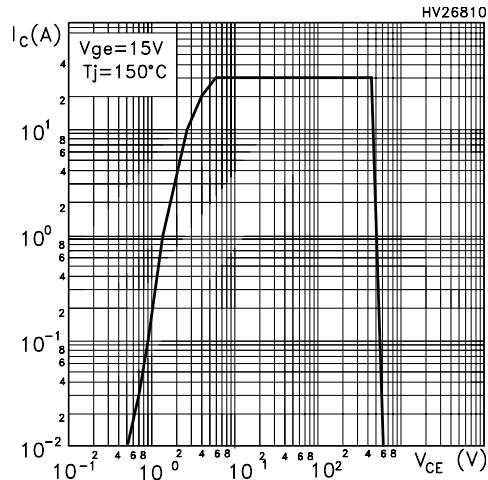


Figure 16: Thermal Impedance

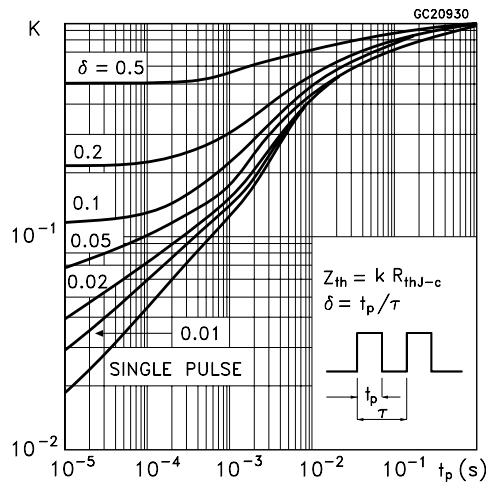


Figure 17: Emitter-Collector Diode Characteristics

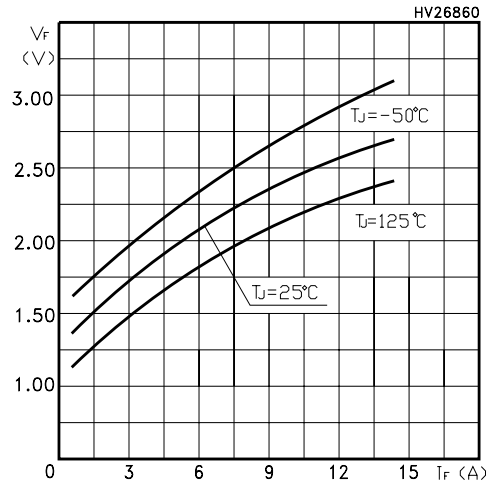


Figure 18: Test Circuit for Inductive Load Switching

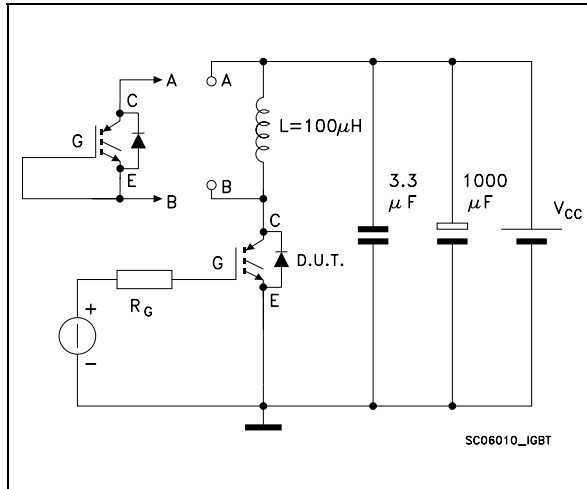


Figure 19: Switching Waveforms

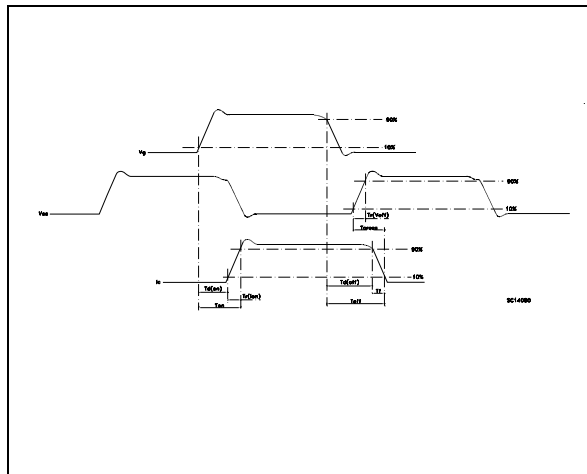


Figure 20: Gate Charge Test Circuit

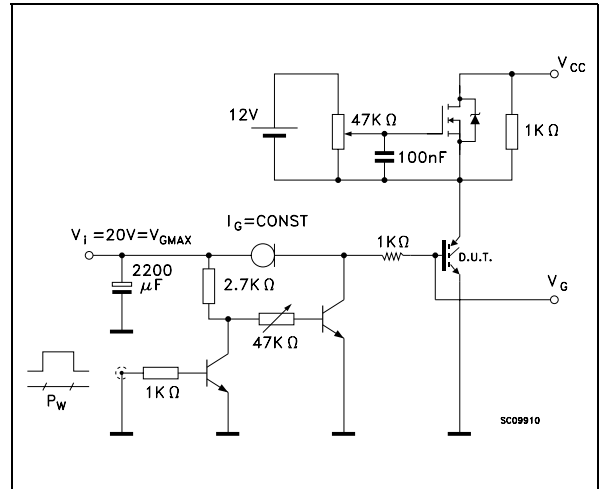
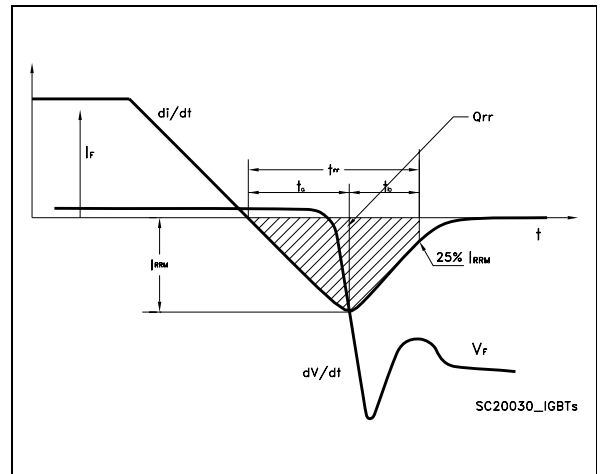


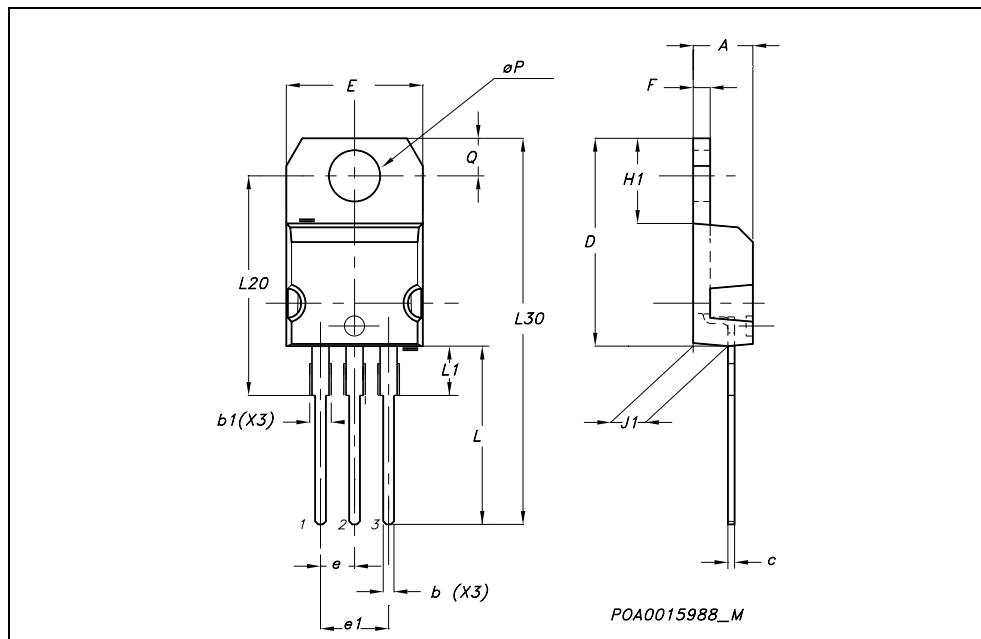
Figure 21: Diode Recovery Times Waveform





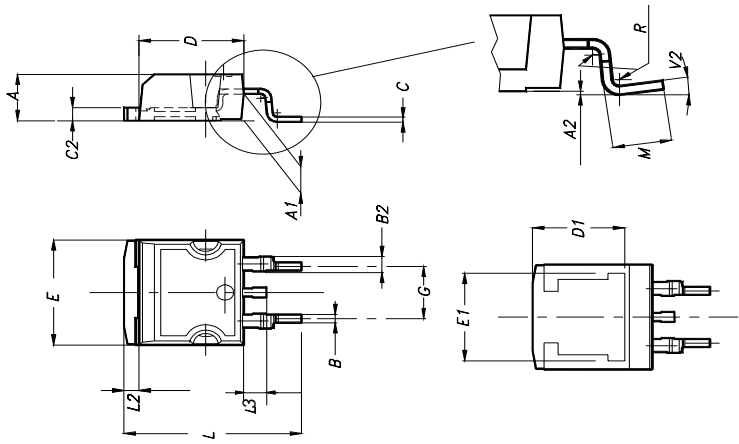
TO-220 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.40		4.60	0.173		0.181
b	0.61		0.88	0.024		0.034
b1	1.15		1.70	0.045		0.066
c	0.49		0.70	0.019		0.027
D	15.25		15.75	0.60		0.620
E	10		10.40	0.393		0.409
e	2.40		2.70	0.094		0.106
e1	4.95		5.15	0.194		0.202
F	1.23		1.32	0.048		0.052
H1	6.20		6.60	0.244		0.256
J1	2.40		2.72	0.094		0.107
L	13		14	0.511		0.551
L1	3.50		3.93	0.137		0.154
L20		16.40			0.645	
L30		28.90			1.137	
øP	3.75		3.85	0.147		0.151
Q	2.65		2.95	0.104		0.116

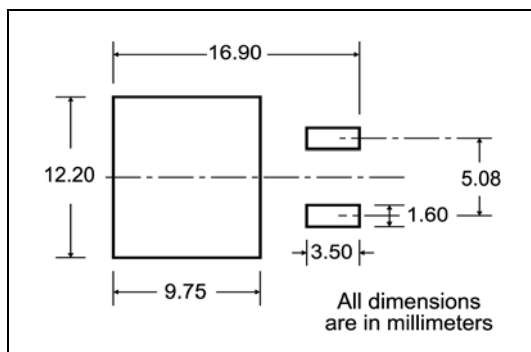


D<sup>2</sup>PAK MECHANICAL DATA

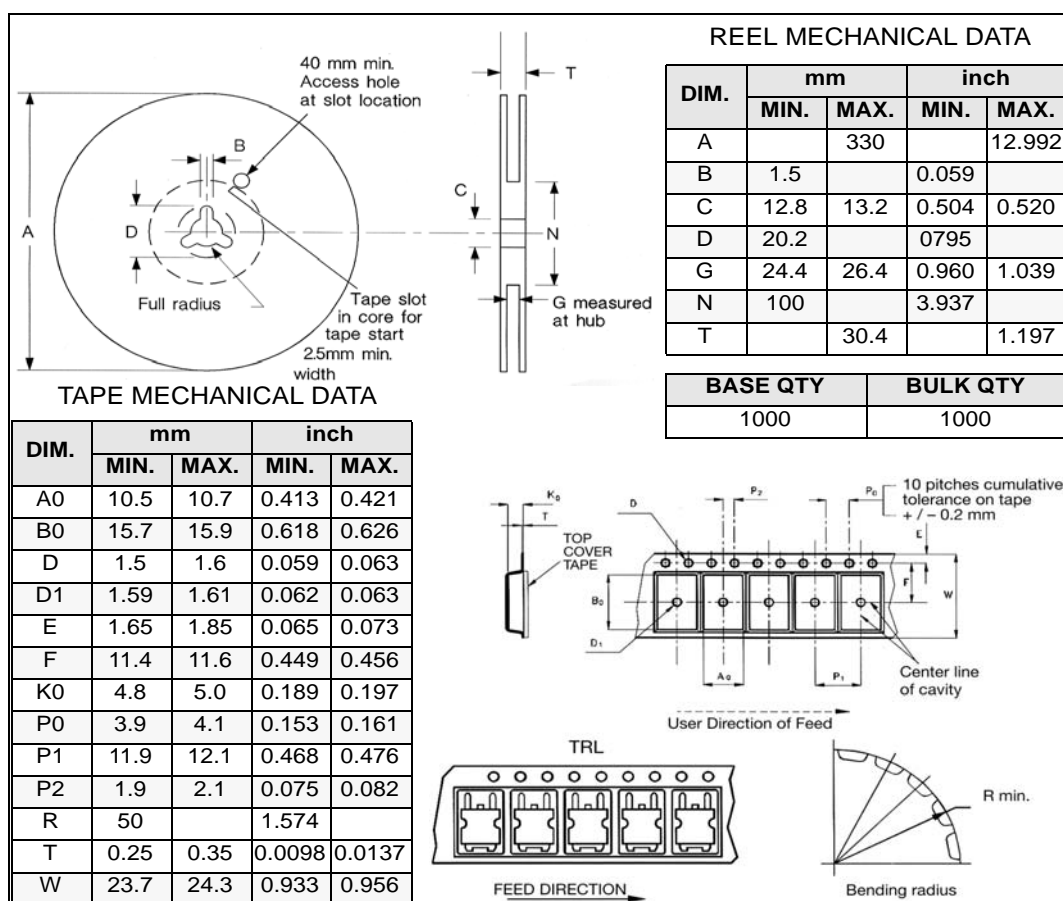
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	4.4		4.6	0.173		0.181
A1	2.49		2.69	0.098		0.106
A2	0.03		0.23	0.001		0.009
B	0.7		0.93	0.027		0.036
B2	1.14		1.7	0.044		0.067
C	0.45		0.6	0.017		0.023
C2	1.23		1.36	0.048		0.053
D	8.95		9.35	0.352		0.368
D1		8			0.315	
E	10		10.4	0.393		
E1		8.5			0.334	
G	4.88		5.28	0.192		0.208
L	15		15.85	0.590		0.625
L2	1.27		1.4	0.050		0.055
L3	1.4		1.75	0.055		0.068
M	2.4		3.2	0.094		0.126
R		0.4			0.015	
V2	0°		4°			



## D<sup>2</sup>PAK FOOTPRINT



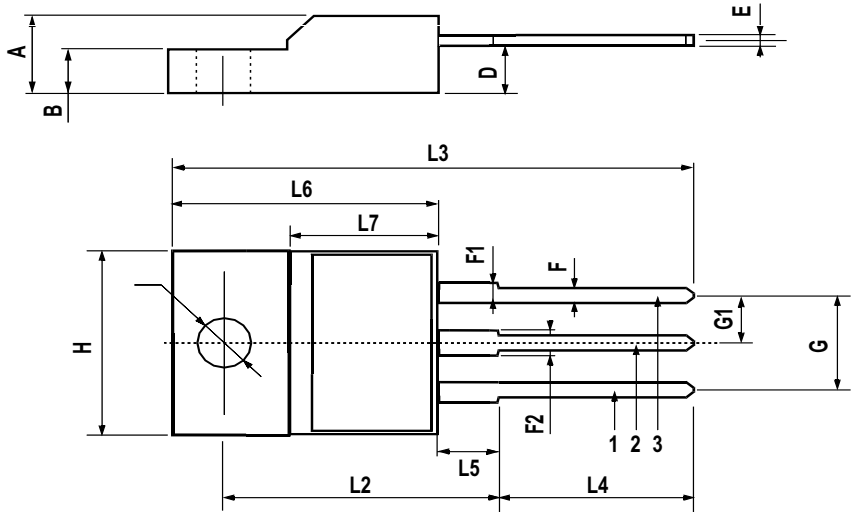
## TAPE AND REEL SHIPMENT



\* on sales type

TO-220FP MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	4.4		4.6	0.173		0.181
B	2.5		2.7	0.098		0.106
D	2.5		2.75	0.098		0.108
E	0.45		0.7	0.017		0.027
F	0.75		1	0.030		0.039
F1	1.15		1.7	0.045		0.067
F2	1.15		1.7	0.045		0.067
G	4.95		5.2	0.195		0.204
G1	2.4		2.7	0.094		0.106
H	10		10.4	0.393		0.409
L2		16			0.630	
L3	28.6		30.6	1.126		1.204
L4	9.8		10.6	.0385		0.417
L5	2.9		3.6	0.114		0.141
L6	15.9		16.4	0.626		0.645
L7	9		9.3	0.354		0.366
Ø	3		3.2	0.118		0.126



**Figure 22: Revision History**

Date	Revision	Description of Changes
14-Jun-2005	1	New release
19-Jul-2005	2	Complete version

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